# THE INSTITUTION OF PRODUCTION ENGINEERS

JOURNAL
*(June, 1946, Vol. XXV, No. 6, Ed. B)*

Contents:



PUBLISHED BY THE INSTITUTION
36, PORTMAN SQUARE, LONDON, W.1


PRICE 5/-

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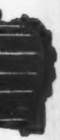

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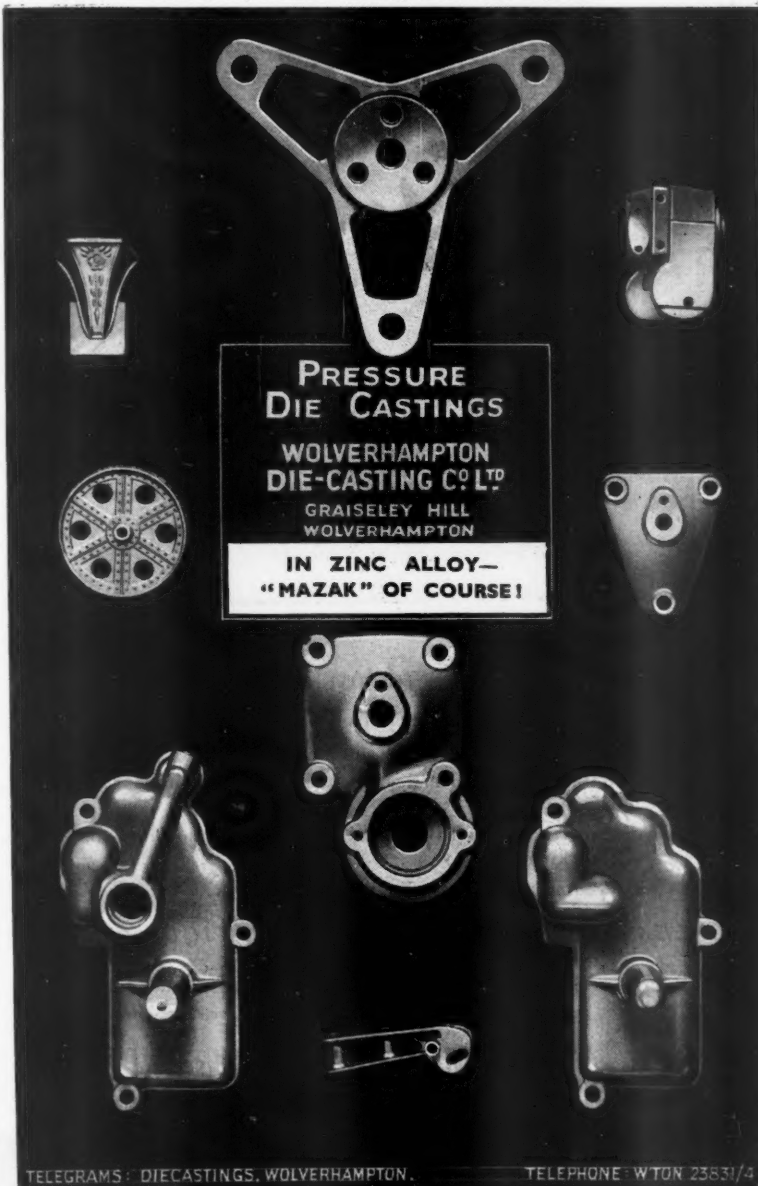
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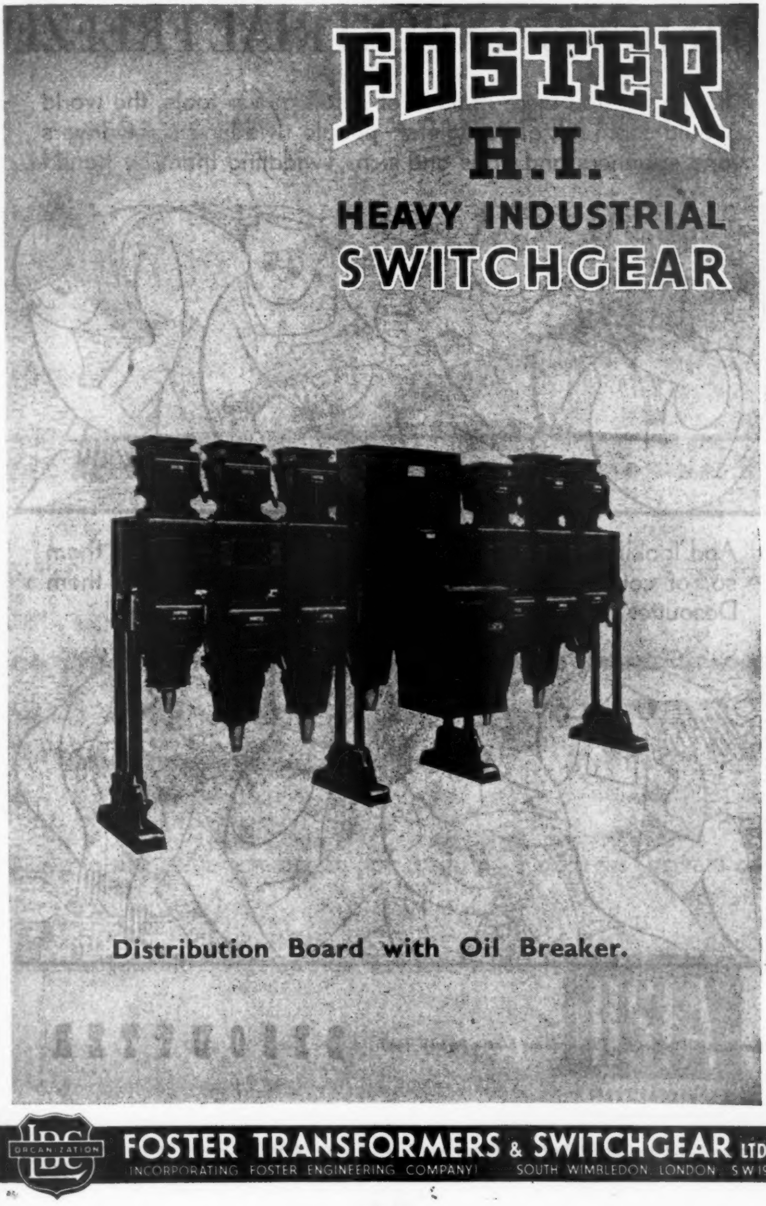
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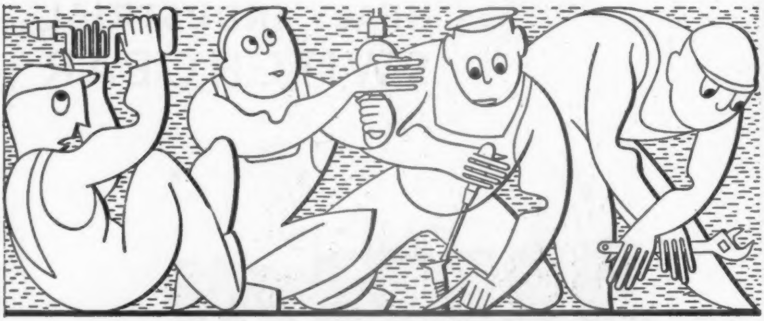

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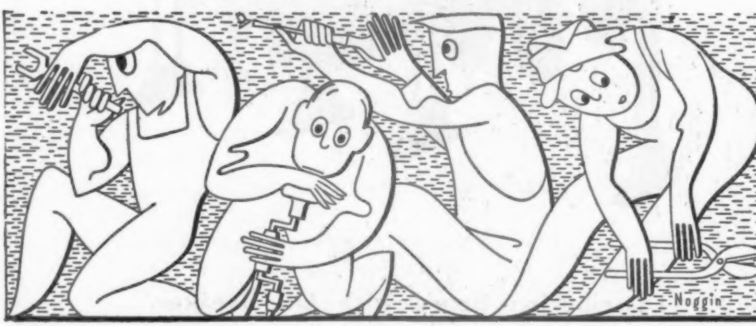


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# INSTITUTION NOTES

## *June, 1946*

**June Meetings.**

4th Wolverhampton & District Graduate Section. A lecture will be given on "Press Tools," by Mr. T. A. Stevens, M.I.P.E., at the Willenhall Evening Institute, Central Schools, Willenhall, at 7.00 p.m.

15th London Section. Visit to the Sperry Gyroscope Co. Ltd., Brentford, Middlesex, at 10.00 a.m.

15th Shrewsbury Sub-Section. Visit to the Lilleshall Company's Blast Furnace and Rolling Mill Plant at Prior's Lee, near Oakengates, at 3.15 p.m.

17th Birmingham Graduate Section. The Annual General Meeting will be held at the James Watt Memorial Institute, at 7.15 p.m. followed by a lecture on "The Construction and Tooling of Single Spindle Automatic Screw Machines," by Mr. A. J. Page, Grad. I.P.E. (retiring Section Chairman.)

20th Wolverhampton Section. A lecture will be given by E. Percy Edwards, Esq., M.I.P.E. on "Broaching - Machines, Tools and Practice," at the County Technical College, Wednesbury, at 6.30 p.m.

28th Wolverhampton & District Graduate Section. Visit to Round Oak Steelworks, Brierly Hill, Staffs, at 7.00 p.m.

YORKSHIRE GRADUATE SECTION. Arrangements are being made by the Committee for a visit to the Yorkshire Dales on Sunday, 30th June, starting at 10 a.m. Transport will be provided, and the maximum cost will be 10s. per head, including one meal. Enquiries should be addressed to the Section Hon. Secretary, J. W. Poole, Esq., Grad.I.P.E., "Tree Tops," Kings Grove, Villa Road, Bingley.

SHREWSBURY SUB-SECTION. The lecture meeting for March took the form of three informal talks: "Germany Today," by L. Farrar, Esq.; "Factory Layouts," by W. C. Johnson, Esq.; "America Today," by H. S. Bruckshaw, Esq. The meeting was held at Shrewsbury Technical College on Saturday, 30th March, at 3 p.m. The talks were well received and were followed by an interesting discussion. Letters of thanks have been sent to the

three speakers, and to Mr. A. Moore, Principal of Shrewsbury Technical College.

**American Society of Tool Engineers**

At the invitation of the American Society of Tool Engineers, Mr. E. W. Hancock, M.B.E., M.I.P.E., General Works Manager of Messrs. Rubery Owen & Co. Ltd., Darlaston, gave an address on the progress and development of the Institution of Production Engineers at the Society's first post-war Convention and Exposition at Cleveland, Ohio, on 10th April. Details of this invitation were published in the February issue of the Journal.

After concluding his address, Mr. Hancock presented to Mr. C. V. Briner, Ruling President of the A.S.T.E., a Certificate of Honorary Membership of the Institution, in perpetuity, together with a specially hand-painted replica of the Armorial Bearings, which will be hung in the A.S.T.E. Headquarters.

Mr. Hancock also took to America with him the following message from the President, Sir Robert McLean, to Mr. Briner :—

Mr. President,

It gives me great pleasure, on the occasion of your annual Convention, to send by the hand of Mr. Hancock a message of Greetings and Goodwill to you and to your Society, from the Institution of Production Engineers of the British Commonwealth.

May I say, also, how glad we are that an envoy from among our Members should be privileged to attend your Convention. For our part we are happy in having as Ambassador to your gathering one who has long had great influence in our Institution and who can, if opportunity offers, speak for our body and its objects and reasons with full authority.

Perhaps it is only those engaged in Engineering Production who understand to the full the unique contribution that the genius and inventiveness of the Machine Tool Designer and Manufacturer have made, not only to the advance of our modern civilization but to our very preservation in times of war. We pay tribute to the remarkable contribution made by the body of men whom you represent and I venture to express the hope that the relations between our two bodies, now having their birth, may grow into cordial friendship and co-operation.

In the regeneration of the world after the war there is a great task ahead of all Engineers. I venture to borrow the words of a very great man when I say to all Tool Makers, from all Production Engineers, "Give us the Tools and we will finish the job."

We shall not make the appeal in vain.

ROBERT MCLEAN,

President of the Institution of Production Engineers.

## Applications for Membership

It is desired to draw the attention of all corporate members of the Institution to the necessity of carefully investigating the qualifications and responsibilities put forward by applicants for membership.

## Obituary

We deeply regret to announce the deaths of the following members :—

Mr. E. L. Lovejoy, A.M.I.P.E., Western Section ;
Mr. W. A. Jaffrey, A.M.I.P.E., Melbourne Section.

## Personal

Mr. L. A. Kelsey, M.I.P.E., has relinquished his appointment as General Works Manager of H. M. Hobson (Aircraft & Motor) Components, Ltd., Wolverhampton.

## June Committee Meetings

14th Finance and General Purposes Committee, at 2-30 p.m., in the TEMPORARY Committee Room, 36, Portman Square, London, W.1.

18th Education Committee, at 10-30 a.m., at the Queen's Hotel, Birmingham.

18th Membership Committee, at 12-30 p.m., at the Queen's Hotel, Birmingham.

— Research Committee, at 11-45 a.m., at Loughborough College, Loughborough, Leics.

Technical and Publications Committee meets every Wednesday at 5-30 p.m., in the TEMPORARY Committee Room, 36, Portman Square, London, W.1.

Until further notice, meetings of the Finance and General Purposes Committee, the Technical and Publications Committee, and the London Section Committee will be held in the TEMPORARY Committee Room at 36, Portman Square, London, W.1. All correspondence is still to be addressed to No. 10, Seymour Street, London, W.1.

### Council Meeting

The next meeting of Council will be held on Friday, 28th June, at 11-00 a.m., at the Institution of Civil Engineers, Great George Street, London, S.W.1.

The Extraordinary General Meeting, arranged to precede the Meeting of Council, as announced in the May issue of the Journal, has been cancelled.

### Issue of Journal to New Members

Owing to the fact that output has to be adjusted to meet requirements, and in order to avoid carrying heavy stocks, it has been decided that the Journal will only be issued to new Members from the date they join the Institution.

### Important

In order that the Journal may be despatched on time, it is essential that copy should reach the Head Office of the Institution not later than 40 days prior to the date of issue, which is the first of each month.

### Books Received

*The New Foremanship*, by F. J. Burns Morton (Second Edition). Published by Messrs. Chapman & Hall, London, 15s. nett.

### Combined Intelligence Objective Sub-Committee Reports

The following titles are additional to those published in the May issue of the Journal :—

Wood Distillation Plant at Brilon-Wald. Final Report No. 128.

Steinkohlen-Bergwerk Rheinpreussen Moers-Meerbeck. File No. XXVI—80.

Fuel Technology and The Reichsvereinigung Kohle. File No. XXXI—28.

Seailles-Dyckerhoff Alumina Process Portlandzement Fabrik Dyckerhoff and Sohne at Amoneburg Bei Biebrich. Final Report No. 167.

The N.V. Organon Pharmaceutical Factory. File No. X—14 and XII—23.

I.G. Farbenindustrie A.G. Plant, Hoechst/Main. File No. XX—11.

I.G. Farbenindustrie Leverkusen. File No. XXI—2.

**Combined Intelligence Objectives Sub-Committee Reports**—*Cont.*

Dessauer Werke Fur Zucker und Chemische Industrie Dessau. File No. XXIII—8.

Chemical Installations in the Cologne Area. File No. XVIII—1.

Englebert Fils S.A., Liege. File No. II—10.

Organization of Telefunken. File No. XXI—1.

Institute Fur Cellulose Chemie Darmstadt. Final Report No. 54.

Papier Fabrik-Kabel Hagen. Final Report No. 55.

Westfalische Zellstoff A.G. (Wildhausen Mill). Final Report No. 56.

Deutsche Erdol A.G. Mineralolwerke Rositz. File No. XXXII—3.

Chemical Industries in Belgium and France During German Occupation. File No. V—30 and XII—18.

A. G. Fuer Stickstoffduenger Knapsack. File No. XXVII—83.

Coal Extraction Plant of Ruhrol G.M.B.H. File No. XXXI—27.

N.Y. Hamburger Gummiwaren-Compagnie Harburg. File No. XXVI—16.

Ceramic Developments of Dr. Rother, Lutz & Co., Lauf/Pegnitz. File No. XXIX—48.

Ernest Beuttler Werke, Dinglingen, near Lahr. Final Report No. 125.

Teuto Metall Werke, Osnabruck. File No. XXVII—8.

Gummiwarenfabrik Hutchinson, Mannheim. File No. XXVI—17.

The Rheinmetall Borsig Works & Proving Ground, Unterluss. File No. XXVII—65.

I.G. Farbenindustrie A.G., Hochst Am Main. File No. XXVI—11.

German Betatrons. Final Report No. 148.

Production of Acetaldehyde, Acetic Acid, Acetic Anhydride and Acetone from Acetylene at the Bunawerke, Schkopau. Final Report No. 75.

# THE TRAINING OF THE PRODUCTION ENGINEER

by SIR ROBERT McLEAN, B.Sc., F.R.Ae.S., M.I.P.E.

*Address given to the Association of Technical Institutions at the Annual General Meeting, on 22nd February*, 1946.

Gentlemen,—On behalf of the Institution of Production Engineers, I welcome this opportunity of addressing you on the subject of the training of the Production Engineer. As a body of eminent educationalists and teachers, you are engaged in moulding the minds of the coming generation of Engineers, and in so doing you are having a profound, and perhaps decisive, influence on the future of this industrial nation. It is a great responsibility—and no less a great opportunity.

Perhaps a word on the genesis of the Institution of Production Engineers may be fitting. It developed in consequence of the unprecedented demands for the supply of armaments for the War of 1914-1918, which brought together a body of Engineers to work out means whereby they could discuss the many difficult production problems that were constantly arising, and to find means for exchanging ideas on Production problems in general. It was soon evident to these enterprising men that a new phase was evolving in the profession of engineering, taking the solid technical foundations already laid by British Engineering as a starting point and creating systems and methods for the better utilization of that knowledge.

From this war-time experience was born the Institution of Production Engineers in 1921. Many of the original Members were Members or Associate Members of the older Engineering Institutions, bent on a more systematic study of these problems ; and, so far as lay in their power, to influence the training and development of those young men destined to become Production Executives. The progress has been rapid. Already the membership of the Institution, including Members, Associate Members, Associates, Graduates, and Students numbers over 6,000, and is steadily increasing.

In its organization the Institution is basically a Federation of geographical Associations. Their office bearers are predominant on the Council, which is thus a true cross-section of engineers engaged in production. The District Associations conduct their affairs by means of papers, discussions, and not least, social gatherings which

add to the corporate spirit. The more outstanding papers are published in the Proceedings of the Institution.

The Institution has done steady, if unobtrusive, work between the two wars and can, I believe, claim that it had accumulated a great reservoir of knowledge—at the disposal of all—when the unprecedented demands of the war just ended broke upon us.

Now we are entering on a new phase. We, as a nation, must export to maintain our population on a decent standard of living, and to do so, we must be competitive in price and quality in foreign markets without the background of an immense home market enjoyed by our main competitor. Equality in our technical Engineering, Design and Production is not enough. We must surpass all competitors and regain the Engineering supremacy that was once ours.

Turning now to the subject of training, it is the view of the Institution that the best training of a Production Engineer is a good technical education to Higher National Certificate standard, linked with sound practical experience gained in the workshops. The latter is ensured by the system of apprenticeship, but if a young man wishes to rise above the status of craftsman, he must take a comprehensive technical course according to the branch of engineering which he intends to follow.

Hitherto the system has been, in the majority of cases, for the young man to attend evening classes after his day's work. We, in this Institution, believe this system to be too great a tax on both the mental and physical energies of youth. We advocate that the student should be enabled to take this training by appropriate release during working hours ; and we are glad to note how many enlightened employers are now adopting this course or, alternatively, conducting their own technical classes during working hours. But these works schools generally cover training to the Ordinary National Certificates with a strong bias in production subjects, and for those who aim at the higher Production Executive posts further training to Higher National Standard is necessary.

This training must include jig and tool design, practical experience on the more advanced and specialized types of machinery, and instruction in such subjects as industrial administration, production control, metrology, and many of the heat and electrical processes now common to engineering.

As you are aware, the Ministry of Education agreed to the granting of a Higher National Certificate in Production Engineering, and in September, 1944, issued revised " Notes for the Guidance of Colleges and Schools on the Arrangement of Courses for Higher National Certificate in Production Engineering under Rules 106 (P)." While the Ordinary National Certificate leading to this course is the Mechanical Engineering Course, it provides a satisfactory foundation

provided the subjects outlined in Appendix 2 of the above notes have been covered. These subjects can be included in the S3 course.

It is evident that this advanced training is almost entirely dependent on the facilities available at Technical Institutions and it is in this respect and in the establishment of courses for the Higher National Certificate in Production Engineering that we invoke the help and collaboration of the Members of your Association.

We do not underrate the difficulties that lie in the way. There is youth itself, not knowing just how to explore the ultimate value of alternative courses, and perhaps advised by parents and elders to be content with the longer established and more familiar courses. There is the need to justify the financial cost of accommodation and plant and metrology equipment in relation to the development of industry in any given area, and the demand for new forms of tuition. There is the problem of a supply of experienced teachers in constant touch with the evolution of thought on production problems. And not least is the final act of persuading the Education Authority to bless the schemes and make financial provision for carrying them out.

In regard to teachers qualified to take classes in workshop training, metrology, etc., many colleges depend on men normally engaged in industry on this class of work, who are prepared to assist by taking evening classes. While these men are specialists with a sound knowledge of their subjects, they are not trained in the art of teaching and may fail, solely through the method of presentation, to rouse and hold the interest of their students. We believe much progress would be made if there were available to such men short vacation courses in the art of teaching, at Training Colleges or Universities. We think it unlikely that many among them would elect a full time teaching career in view of the higher rewards which they will get as they climb the ladder of promotion in industry.

For the full-time teacher, close contact with industry will be essential if he is to keep in touch with the ever-changing technique of production and new developments. He could, with great advantage, spend a period in industry say, every two years, to become acquainted at first hand with new types of machines and new methods. We have no doubt that industry and especially the Production Engineers in industry would make them welcome and give every help in their power.

Our Institution gave evidence before Lord Eustace Percy's Committee and we were glad to note how many of our views were endorsed in the Report as issued. We have submitted a Memorandum to the Minister of Education, somewhat modifying that submitted to the Percy Committee, dealing in more detail than is possible on this occasion with the Institution's views on the technical training of the Production Engineer. We will be glad to make copies

available for such members of your Association as may desire to have them.

To conclude, we are anxious to see established in all engineering districts facilities for students to take a Higher National Certificate in Production Engineering. We therefore appeal for your co-operation.

We hope to see the day when the most promising of our engineering students will elect Production Engineering as a career, for on them will fall a heavy responsibility in the struggle to rebuild our economic structure on the foundation of a great flow of exports to Empire and Foreign markets against whatever competition we may find.

The Members of your Association are in a position to exert a great and powerful influence towards this end. We, on our part, can assure you of whatever co-operation and assistance lies within our power.

# MEETING OF ASSOCIATION OF TECHNICAL INSTITUTIONS

## 22nd February, 1946

In speaking of the above meeting at the meeting of Council on 22nd March, 1946, Dr. Schofield, Vice-Chairman of Council, said: "The success of the meeting was particularly gratifying to me, as I have been Hon. Secretary of the A.T.I. for 21 years and last year terminated my service as Chairman of its Council.

"The representatives of 220 technical colleges who attended were immensely impressed by the address given by the President of the Institution and by the novel 'brains trust' he brought with him. The resultant discussion was both valuable and illuminating.

"I feel there is a great need for making young engineers conscious of the possibilities of membership of the Institution, and suggest that the closest educative contact be maintained between the Institution and the larger technical colleges, particularly in regard to liaison between our Sections and such colleges. Students might well be invited to attend the Sectional Meetings and so have an opportunity of hearing addresses and discussions by prominent Institution members. I also recommend that college libraries should be supplied with our Journal and other publications.

"The teaching of Production Engineering in colleges is hampered by lack of adequate instructors. Many large firms are now lending specialist members of their staffs to technical colleges for a day or a half-day a week, as the colleges cannot as yet obtain anything like the number of full-time teachers of production engineering required. Even if they could do so, it is doubtful if such teachers would remain efficient over a period of years without something of the nature of "refresher" courses in Industry.

"The I.P.E. is the only large Institution of its kind whose corporate membership is not regarded by the Burnham Committee as a graduate qualification. The time has come for the Institution to re-examine the criteria on which its membership is granted and make its claim. If membership of the Institution was to be so recognized, it would inevitably help to establish the prestige of the Institution."

# COVENTRY SECTION
# ALL-DAY WELDING CONFERENCE

## 6th April, 1946

An inaugural event to celebrate the 25th Anniversary of the founding of the Institution of Production Engineers took place on Saturday, 6th April, when a very successful production conference was held at the Rugby works of the British Thomson-Houston Co. Ltd. The object of the Conference was to put before all the leading engineers of the Midlands the many advantages of the various different types of welding technique in increasing productive output in such widely differing fields as light and heavy engineering, shipbuilding, housing construction and all forms of domestic equipment.

The Conference was presided over by a founder-member of the Institution, Sir Norman V. Kipping, J.P., M.I.P.E., M.I.E.E., Director-General of the Federation of British Industries, who was supported by the Rt. Hon. Lord Sempill, A.F.C., Hon.M.I.P.E., Mr. J. E. Blackshaw, M.I.P.E., Chairman of Council, and Major C. B. Thorne, M.C., Director-General Secretary of the Institution of Production Engineers.

Prominent engineers from as far away as Nottingham, Lincoln, Luton, Wolverhampton, Leicester and London helped to constitute the 200 members present. A series of papers was given by experts in all the varied branches of welding, together with actual practical demonstrations and exhibits illustrating the points made by the lecturers.

In his luncheon address, Sir Norman Kipping, emphasizing the need for production engineers to spread their knowledge widely, said :—

" I feel very much refreshed by the evidence that, in spite of all the manifold frustrations of today, there is still virility and enterprise, and there was never more need for it. Our need today is not perhaps so much the enterprise of the salesman, as of the Manager, the Engineer, and the Designer. There is a great shortage of labour today, and this means more mechanization, better tooling, better processes, and no doubt more welding. There have been some very remarkable advances in welding, not merely in the basic systems, but in the understanding of what happens during the weld, and this brings with it a greater likelihood that the welding we do will be *good* welding."

Sir Norman continued : " I think the stage has now been reached

when there is room for more thought to be given to the organizational treatment of welding in the factory. We may ask in what circumstances is a welding shop to be preferred to the insertion of isolated welding stations in progressive manufacturing layouts. Of course, more welding enthusiasts will prefer the former and will put up weighty and convincing arguments in support of their case, but I think they will very often be wrong, except perhaps in heavy engineering shops. Welding, in most cases, is essentially an assembly process, and if your product is one that can be assembled by progressive methods and subject to exceptions when there is an electric plating problem or the like, then the welding operation should be made a part of a continuous assembly. You can see the challenge which this presents to the welding engineer. He must get the mystery out of his technique and get down to, or up to, the stage where consistently good welding is a ' lever-pulling ' business.

" As I look round, I don't see many signs that the frustrations of today are getting the Production Engineer down. The Production Engineer always has the pride of the expert to sustain his morale and to absorb his interest. Nevertheless, none of us can fail to be very deeply concerned about the problems facing industry and the country, and I am sure that each one of us has a part to play in this solemn business of national recovery. First of all, there is ignorance most abysmal. I am inclined to think that Production Engineers themselves should be taken to task for their cheerful aloofness from the fundamentals of the economic situation. If intelligent engineers do not take the time and interest to grasp the fundamental essentials and not be put off by the jargon of the economists, what chance have we of putting the facts over to the rank and file ?

" What chance have we, moreover, of convincing those who have no experience of managing industry of the facts we ourselves know so well ? When I think of the difficulties and complexities of managing a single large factory, I cannot conceive how anyone can be so foolish as to propose to multiply those problems by the creation of vast national units, or to create centralized problems which would be quite beyond human powers to manage with efficiency.

" Our task must be to devise solutions to the things we know to be bad, without sacrificing so much that we know to be good. I commend to you, and to the Institution, that you should devote yourselves to your share in that task. There is no more worthwhile thing to do."

Sir Norman concluded his address by thanking Mr. W. W. Vinsen, Director of Manufacture, British Thomson-Houston Co. Ltd., and his co-directors for their hospitality, and for the really excellent arrangements made in all respects for accommodating the large number of delelgates.

Mr. Vinsen, in replying, said: "In these stressful days, in which Great Britain is trying to recapture her former position as a leading industrial country, the paramount need of rapidly stepping up production is exercising our minds. The technique of welding provides the Production Engineer with a means of achieving in some measure, lower costs, simplification of design, and increased production. We all know of the difficulties experienced in obtaining iron castings; it is now a very familiar friend. The shortage is felt, I think, in all branches of the Engineering Industry, and is retarding the housing programme. I feel sure that this is a most serious situation which can be improved by the closer study of our products with the object of displacing iron castings by fabricated structures.

"We have travelled some way in this respect, but there still remains much to be done, both in the propagation of the idea and in its application. I think that increased publicity is still required to convert more of the Engineering Industry to the merits of fabrication.

"Before I sit down, I would like to thank Sir Norman Kipping for his kindly reference to this Company for the facilities afforded for the holding of this Conference, and I hope that you will all leave our Works with a feeling of pleasure at a job well done."

The Rt. Hon. Lord Sempill, in thanking Sir Norman Kipping for presiding over the Conference said: "There is no doubt that it is desirable that all manufacturing organisations should encourage such Conferences. This Conference is adding to our knowledge of the art, which is all-important, and enables us to renew those personal contacts, which are so vital, since without the human touch nothing that is permanent can evolve. We, as Production Engineers, thoroughly appreciate the psychological side, but until this fundamental concept is applied all round, the progress desired by Sir Norman Kipping and Mr. Vinsen will not come about.

"We are met at the B.T.H. Works, and we see not only a highly efficient management, but the most modern equipment. If this organisation is operating with all-round vigour and no restrictions from capital or labour, we may be sure that maximum production consistent with quality will result. We have not only, as Mr. Vinsen said, to work to live, but we have also to increase production so that our standard of living may itself be increased. Until we are able to do that, there can be no increase in the standard of living.

"How can we achieve this? Certainly not by officialdom forcing us to adopt a narrow ideology, outdated by experience and disproved by results. Well, if we agree, what are we to do? Let us see what people in other countries are doing. We can certainly learn by experience from other concerns interested in welding in America. I will take the case of a particular organisation in the U.S.A. which, in the last ten years, has increased its output 2·8 times in terms of

money value. The price of the product during those ten years has been reduced by some 55 per cent. of the 1934 figure. During this period, the average remuneration was increased 2·7 times and the dividend three times. That is the standard which we want to see achieved, and it can be done by marrying technology to psychology.

"Today we pay a tribute to Sir Norman Kipping, one of the founders of the Institution of Production Engineers. He was taken out of his business, one of the best organised in the country, by Captain Oliver Lyttelton, and appointed Advisor on Production. Today he is the Director-General of the Federation of British Industries. We not only extend to him our thanks for coming here today, but our very best wishes for the future. The Federation of which he is Director-General extends all over the world, and can only be effective if we increase production."

In congratulating the Coventry Section on the manner in which the Conference had been organised, Mr. J. E. Blackshaw, Chairman of Council, said: "I think this is the first all-day Conference yet to have been organised by the Institution of Production Engineers, and in that respect, Coventry is to be congratulated. I should imagine that the organisers, in the face of their great responsibilities, must be feeling immensely relieved that their efforts have met with such unmitigated success.

"You will appreciate that organising such a Conference presents a considerable problem. Suitable subjects have first to be selected, and individuals found to give the papers. Much initial work has to be done. The choice of a Welding Conference was, I think, a particularly happy one. Welding is unquestionably one of the sections of engineering which is often relegated to some dark hole, and I think Members - particularly those who have not been associated with welding - will have been given an insight today into the problems connected with welding, and are thus better able to appreciate that it is a matter which does require considerable preparation, and that there is more in it than most of us realise. If this Conference has done nothing more, it has served at least to bring home this point.

"I would like to express, on your behalf, our thanks to the participating firms who have made the practical demonstrations possible. It requires very little imagination to appreciate the trouble and expense to which they have gone to provide practical demonstrations for your benefit, and I think they are to be congratulated and should receive our hearty thanks. I am sure I am expressing your wishes in thanking them.

"I think also we should not close this meeting without reference to Mr. Newbold, who is President of the Coventry Section, and to Mr. Jackman, who seems to have done the 'donkey work.' We all realise how much work has been involved. There are always the

few who shoulder these jobs, and I would like to make an appeal to some of our younger members to take over some of our activities from the older ones. I personally should be pleased to surrender my office to one of the younger members.

"We must also thank Mr. Buckland and Mr. Riley, the other two members of the Committee which organised this Conference, and I ask you to show them your full appreciation."

Sir Norman Kipping was then asked officially to close the Conference, which he did after expressing the hope that the experiment would be the forerunner of other successful Conferences.

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# BRIGHT ELECTROPLATING AND ELECTROPOLISHING

by V. McWILLIAM CHANDON, Int.A.M.I.P.E.

*Presented to Preston Section, 14th November, 1945*

My lecture is divided into three parts :—

(*a*) A quick and brief theoretical exposition of atoms and ions to help you to follow the rest.

(*b*) A simple exposition of the theories propounded to explain the mechanism of bright electroplating and electropolishing.

(*c*) Some practical information about both bright electroplating and electropolishing.

## The Universe

Our small world in the Universe is composed of one star and nine planets revolving round the star. That star we call the Sun, our Sun. Evidently space is a plentiful commodity in the Universe, for the next star to our Sun is $25 \times 10^{12}$ (25 million millions) miles away. Therefore, as far as matter is concerned, matter as we know it on our earth, the Universe to us *is* mostly emptiness. However, all this space is teeming with radiations of many kinds, so that it is not strictly a vacuum.

## The Atom—a World of Its Own

Now, after looking at the incomprehensible vastness of the Universe, let us look at the incomprehensible smallness of the atom and its constituents.

The 92 elements we know are composed of nothing else but atoms, and all the atoms are built up of the same materials ; that is :—

(*a*) Protons, which form the nuclei of atoms. These protons display an electrical positive charge and form the bulk of the mass of the atom.

(*b*) Neutrons, which also go to make the nuclei of atoms, and are of an equal mass to that of the protons. These neutrons are probably composed of a positive proton neutralized by the juxtaposition of an electron.

(*c*) Electrons, which revolve round the nucleus of an atom and are made up of an electro-negative charge.

Complete atoms are electrically neutral, the number of electrons being such that it neutralizes the positive charge of the nucleus.

Negative electrical charges or electrons (ε) are of very small mass; they have been weighed and found to be only 1/1840 the mass of a proton or of a neutron. As protons and neutrons form the nuclei of atoms, we consequently know that the mass of an atom is concentrated in the nucleus.

Now let us look at a typical atom, that of Lithium, for instance, It is third in the list of elements, therefore its atomic number is 3. Its atomic weight is 6·94. It is composed of a nucleus containing three protons and four neutrons and of three electrons rotating round the nucleus. The three electrons rotate in two orbits, an inner orbit of two electrons and an outer orbit of one electron.

The shape and relative sizes of the different orbits traversed by electrons in their travels around the nucleus of an atom are remarkably similar in shape and proportion to those followed by the planets round the Sun. The atom, like the Universe, is mostly made of emptiness, although here—as in the Universe—the space is not a vacuum, but is teeming with electro-magnetic waves.

## Ions

Now that we have some idea of what atoms are made of and what they are like, we shall see how they behave in relation to bright electroplating and electropolishing. Some atoms are very stable of structure, others are not so stable. Some of the not so stable atoms are subject to *losing* one, two, or more *electrons* from their outer orbit. Others of these not so stable atoms are subject to *gaining* one, two or more *electrons*, and adding them to their outer orbit. Whenever any of these not so stable atoms have either lost or gained electrons they become *ions*. The atoms are said to be ionised; they exhibit an electrical charge.

Atoms ionise instantly as molecules of certain compounds *dissociate* themselves into atoms, the result being not atoms, but ions. It can be stated, if one prefers, as follows: that the compound has been ionised, meaning that the atoms forming the molecules have exchanged electrons, one atom losing electrons, the other atom gaining electrons. As electrons are negative electrical charges (the unit of charge —e), it follows that when an atom loses electrons it becomes positively charged, and when an atom gains electrons, it becomes negatively charged.

Molecules of alkalis, salts and acids do dissociate (ionise) readily; and they do so the more readily, the more their solutions are diluted.

Ionisable compounds in the liquid state are called electrolytes and are conductors of electricity. It is this property that makes us interested in them. Take a compound such as NaCl, for instance—

Sodium Chloride, our table salt ; this salt contains not only the molecule NaCl as such, but also dissociated molecules or ionised atoms or ions.

Ionisation of Sodium Chloride is explained as follows : Sodium-Na—has 11 electrons, of which one is in the outer shell or ring.

Chlorine—Cl—has 17 electrons, of which seven are in the outer shell. Now they are both not so stable atoms, and they wish to become more stable ; Na parts with the one electron of its outer ring, and becomes a positively charged ion ($Na+$). Cl, on the contrary, takes that negative electronic charge from Na and becomes a negatively charged ion ($Cl-$), with eight electrons in its outer ring instead of seven ; thus both have acquired a more stable structure.

## Ionic Migration

In an electrolyte, we have molecules which have dissociated, producing both positively and negatively charged ions. The fact that these ions have electrical charges, and are in a medium in which they can float and move about, renders them susceptible to migrating towards an electrical charge of opposite value to theirs.

If, therefore, we have electrodes in our electrolyte and apply charges to them such as a direct current, the positively charged ions will migrate towards the negative electrode or cathode, and we call them cations ; also the negatively charged ions will migrate towards the positive electrode or anode and we call them anions.

Ions of metals, hydrogen, and alkalis, which are electro-positive, migrate to the cathode. Ions of acids, oxygen and other elements which are electro-negative, migrate to the anode.

An example of ionic migration of dissociated molecules is given by Copper Sulphate. The molecule is $CuSo_4$, which dissociates or ionises into two ions, one the copper ion, $Cu++$, the other the sulphate ion $SO_4^{--}$. This latter sulphate ion is very stable as such, and that is why it does not ionise further into sulphur ions and oxygen ions.

The copper ions, being positively charged, migrate to the cathode, negative pole, and there receive two electrons which brings them to the state of Atomic Copper and as such, these copper atoms attach themselves to the cathode ; their accumulation forms crystals of metallic copper and covers the whole surface of the cathode ; we say it electroplates it.

The sulphate ion, on the contrary, being electro-negative, migrates to the anode ; this latter possessing a positive charge which attracts electrons (electrons being negative charges). Then the sulphate ion becomes an unstable compound lacking two electrons and looking for some ; it helps itself by sharing two electrons from two atoms

of hydrogen, taking this hydrogen from the ambient water, and the oxygen of this water, being thus separated, bubbles to the surface of the electrolyte. The sulphate ion $SO_4$, having thus acquired one hydrogen molecule $H_2$, has now become Sulphuric Acid, $H_2SO_4$.

*Note.* Some of the theoretical explanations, especially that on ionisation, have been adapted to make them clearer and easy to remember. They are not theoretically exactly correct, as students of Physical Chemistry among you may realise.

**Bright Electroplating**

Electroplating is usually followed by polishing because the plated surfaces, being left a dull matt tone, are not pleasing to most eyes. Mechanical polishing is an expensive item of production, especially expensive in man-hours, therefore new methods are sought.

It has been discovered that, by adding certain substances to an electroplating bath, a satisfactory bright finish can be obtained on articles without any further polishing by mechanical means being necessary. It was also found out that with some bright electro-deposited metals, the bright finish—although not quite what was required, only necessitated a fraction of the mechanical polishing previously expended upon it to bring it up to expectations.

**Theory of Bright Electroplating**

When electroplating is taking place, metallic atoms from ions are deposited on the cathode. The metallic atoms thus deposited arrange themselves so as to form crystals ; the particular crystals of the metal being deposited. The coarser the grain of these crystals, the duller the surface of the plated metal will be. The finer the crystal structure, the more the surface will reflect light, and the brighter it will be. Therefore, to increase the lustre or polish of electroplated metals, we try to reduce the size of the metallic crystals formed.

This is obtained, for instance, by introducing in the bath certain substances, such as proteins, which remain suspended in the solution in a colloidal state. The colloidal particles floating about in the solution are motioned by their own charges, with the migrating cations, towards the cathode and become occluded by, or inter-mixed with, these cations as they settle on the cathode. We say that the colloidal substance has been adsorbed by the deposited metal.

Now what concerns us greatly is that, by being so adsorbed, the substance has made the metallic ions reduce their crystal size, thereby producing a brighter surface. The reduction of the crystal

grain size is also brought about by the addition of a substance having a " common ion " with the metallic salt of the bath, which common ion is capable of forming a " complex salt." This principle is used in practically all electroplating solutions. To silver cyanide, copper cyanide and others used in plating solutions, both sodium and potassium cyanides are added to increase the cyanide ion (CN—) concentration and thereby lower the concentration of the metallic ions in the bath.

The reduction of grain size, be it brought about by adding either a common ion substance or adsorbable colloidal substances, is explained as follows :—

Around a cathode is a film of cations of the metal, but also other constituents, some of which—not being ionisable—we may call inert particles. There is a certain proportion existing between the number of metallic ions and the number of inert particles ; it so happens that when the number of metallic ions is great in comparison with the number of inert particles, the crystal formation goes on merrily and the crystals grow to a large size, producing a coarse structure or surface. Now, if we increase the proportion of inert particles to that of metallic ions, there is considerable interference with the crystal growth, with the result that increase in size is prevented and formation of a much greater number of smaller crystals is encouraged. This gives, of course, a finer surface which is brighter.

Other phenomena, such as rhythmic banding and striated structures, affect the brightness of electro-deposited metals. These phenomena are due to the periodicity of the action in electroplating—at least in cyanide baths—and the following is an attempt at explaining what happens :—

As the metallic ions are being deposited on the cathode, the latter is left surrounded with a film of solution depleted of metallic ions ; the metal deposition is thereby hampered and goes on at a reduced rate. This gives rise to a discharge of atomic hydrogen which, becoming molecular hydrogen and moving upwards, promotes the diffusion of further metallic ions, thereby enriching the film around the cathode, and a further cycle of deposition of metal takes place ; this deposition again depletes the film of metallic ions and the cycles continue with regularity.

Periodicity causes new crystal nuclei to be formed each time the metal deposition restarts, and interferes with the free growth of these crystals each time the metal deposition is reduced in intensity.

## Practical Data on Bright Electroplating

Bright electroplating is used with nickel, silver, copper, chromium and cadmium baths. To obtain the effect, a brightener is added to the solution, a brightener being described as a substance which,

when added to an electroplating solution, promotes an electrodeposit possessing a greater power of reflecting light than that which would be produced without its use. The following chemicals are used as brighteners :—

*For copper baths*

Arsenious Acid, $As_2O_3$, dissolved in potassium cyanide, Sodium Thiosulphate ($Na_2S_2O_35H_2O$), this plating solution being composed of :—

| | |
|---|---|
| Sodium thiosulphate ($Na_2S_2O_35H_2O$) ... ... | 200 gms. |
| Cuprous chloride ($CuC1_2$) ... ... ... | 20 gms. |
| Sodium bi-sulphate ($NaHSO_3$) ... ... ... | 10 gms. |
| Water ... ... ... ... ... ... | 1 litre. |

Temperature 25°. Current density 10 amp./sq.ft. Cathode efficiency 90% (that is, 90% of current efficiently used in depositing metal, 10% being wasted producing hydrogen gas.)

*For nickel baths*

Nickel Ethyl Sulphate has been used since 1905. About 1904, it was found that adding 1 oz. of cadmium chloride to 10 gallons of nickel solution produced brighter plating. It has to be replenished at intervals. Conversely, it was found that 2 oz. of single nickel sulphate in 10 gallons of a cadmium solution produced a brighter cadmium deposit.

The following baths for brighter nickel have been patented, some in the U.S.A., some in Britain :—

| | | |
|---|---|---|
| 1. | Nickel sulphate ... ... ... ... ... | 160 gms. |
| | Nickel benzoldisulphonate ... ... ... | 30 gms. |
| | Boric acid ... ... ... ... .. | 30 gms. |
| | Water to give a p/H of 2·5–4·5. | |
| 2. | Nickel sulphate ... ... ... ... ... | 150 gms. |
| | Potassium chloride ... ... ... ... | 50 gms. |
| | Sodium toluene disulphonate ... ... ... | 40 gms. |
| | Boric acid ... ... ... ... ... | 15 gms. |
| | Water ... ... ... ... ... ... | 1 litre. |
| | p/H—5·0 maximum. | |
| 3. | Nickel sulphate ... ... ... ... ... | 150 gms. |
| | Nickelous hydroxide ... ... ... ... | 25 gms. |
| | Magnesium chloride ... ... ... ... | 60 gms. |
| | Napthalene trisulphonic acid ... ... ... | 30 gms. |
| | Boric acid ... ... ... ... ... | 15 gms. |
| | Water ... ... ... ... ... ... | 1 litre. |
| | p/H—5·0 maximum. | |

4. By adding cobalt to nickel solutions bright deposits are obtained, as well as the hardness of the surface being increased, a typical bath being :—

| | |
|---|---|
| Nickel sulphate ... ... ... ... ... | 240 gms. |
| Nickel chloride ... ... ... ... ... | 45 gms. |
| Nickel formate ... ... ... ... ... | 45 gms. |
| Cobalt sulphate ... ... ... ... | 15 gms. |
| Ammonium sulphate ... ... ... ... | 1 gm. |
| Formaldehyde ... ... ... ... | 0·5 to 1·0 gms. |
| Water ... ... ... ... ... ... | 1 litre. |

p/H—4·2–4·3.
Current density 40–60 amps./sq.ft. Temp. 60°C.

### Bright Silver Plating

The deposition of bright silver has been in use since 1843, when it was found that by adding a few grains of carbon disulphide per gallon of solution the deposit was bright instead of dull.

To this day, silver brights are prepared by adding 100 gms. of potassium cyanide, 50 cc. of carbon disulphide, and 25 cc. of methylated ether to 2 litres of silver solution. The mixture, in a bottle, is shaken up at intervals for several days, left to settle and then added to the silver bath at the rate of 12 cc. per 100 litres. This is renewed daily if the vat is worked all day.

### Chrome Plating

This is always electro-deposited with a bright finish, as it is so hard a metal that it is next to impossible to polish it by mechanical means. Good chrome plating can only be done on a nickel base. Chrome plating on steel is only waste of time and money, as many of you will have sadly experienced with many examples of this cheap kind of work ; chrome on steel will flake.

The brighter and more polished is the nickel foundation, the brighter will be the chrome finish. Usually ·0006 in. to ·001 in. thickness of nickel is deposited.

For bright chrome plating, it is best to purchase standard bright chrome salts from manufacturers. Dull chrome can be deposited on steel satisfactorily, and this is used to reclaim used machinery or salvage components that have been machined under size. Up to $\frac{1}{16}$ in. to $\frac{1}{8}$ in. and more can be built up, but this is a subject not coming under bright electroplating.

### Electropolishing

Electropolishing is in opposition to electroplating processes of anodic action. It is in the same category as the etching of ferrous

materials prior to electroplating to ensure adhesion, and also as the anodic oxidation of aluminium, magnesium and their alloys.

Electropolishing is used in the laboratory to polish metallographic sections for inspection under the microscope. It is also used in industry to polish metals as well as to give them a brighter surface.

## Theory of Electropolishing

Metallic anodes react with electrolytes. These reactions involve the anions. If the result of such a reaction is readily soluble in the electrolyte, the anode carries on being disintegrated and continuously dissolves, such as a copper anode in an acid copper sulphate electrolyte.

On the contrary, if the products of the reaction of anode with the anions is not soluble (silver anode in a soluble chloride solution), a film of this insoluble product will form over the anode and develop an electrical resistance which will increase until it is high enough, in a short time, to bring the reaction to an end.

Again, if we select such soluble salts as will form a concentrate in the vicinity of the anode surface, we shall build there a viscous film. The electrical properties of this viscous film are such that it interferes with the continuous solution of the anode material.

If the electrical resistance of this film is appreciably higher than that of the electrolyte, the current will be impeded as a result and will concentrate on those portions of the anode which are outside this impeding layer.

On these local points the current density will be very much higher than elsewhere, and correspondingly rapid dissolution of those points will take place.

It is assumed that a matt surface consists of a series of local crests ; the action which takes place, therefore, gradually eliminates these crests which, of course, produces a gradual smoothing of the surface.

Now, if you can produce a very thin film, so much the better ; the thinner this viscous impeding film, the more complete will the levelling of the surface be, and consequently also the polish imparted. In mechanical polishing, on the contrary, a certain amount of bending down of these crests takes place, and a flowed amorphous surface is produced.

These viscous films are very thin indeed ; they must be in the order of a few microinches ; but since you were given an idea of how incomprehensibly small atoms and ions are, you can now visualize how it is possible for some ions to float about in such a thin film and be quite at ease performing their work, and for other ions to be impeded by electrical charges even in such a narrow space.

## Practical Data on Electropolishing

### Electropolishing of Stainless Steel—Phosphoric Acid Process

The bath is as follows:—

| | |
|---|---|
| Phosphoric acid ... ... ... ... | 42% by weight. |
| Glycerine ... ... ... ... | 47% by weight. |
| Water ... ... ... ... ... | 11% by weight. |

Temperature near 100°C. Current density 15 to 80 amps. sq./ft.

The lower current densities produce more anodic solution of metal from the surface ; this local etching action is probably caused by a drop in the efficiency of the viscous film. The total amount of metal removed is low, about 0·0005 in. Most dimensional tolerance limits can therefore be adhered to.

With phosphoric acid electrolytes, the anodic products are soluble, and so form a viscous layer over the anode surface as a result of local concentration ; this diffuses only slowly into the main body of the electrolyte, and the result is good polishing with very little etching or local action.

### Sulphuric Acid Process

The solutions are composed of sulphuric acid, glycerine and water. In this process, sulphates are formed which are less soluble than the corresponding phosphates of the phosphoric acid bath.

As a result, the anodic layer is not so viscous, and more local action takes place. Organic agents are added, such as citric acid. Reaction compounds are precipitated which form a sludge ; this is removed from time to time. These solutions last longer—one to two years—than phosphoric acid solutions, and have more stable working conditions, such as voltage and current density.

The soluble phosphates in phosphoric acid solutions, in time, increase the current density. One adds phosphoric acid, but nevertheless the solution deteriorates. Lead-lined tanks are suitable for both solutions. Currents up to 100–200 amps. per sq. ft. are used. Voltage about 15 volts. Rectifiers are preferable to dynamos for finer voltage control.

Electrolytes working at lower amperages have a more uniform current distribution and a better throwing power. Positive contact to the anodes should be provided and the tanks lagged, as they work near boiling point. Stop-off lacquers should be used to protect jigs, etc.

### Electropolishing of Nickel

One solution is made of sulphuric acid—73% by weight in water. Current density 250 amps./sq.ft. Temperature 30°C. Time, ½ to

2 minutes, and 4 to 5 minutes. Low current densities result in pitting. Temperature may range from 10° to 50°C.

## Electropolishing of Aluminium

The perchloric acid-acetic anhydride electrolyte has been used, but is dangerous and could not be used industrially. For pure aluminium an alkaline bath has been used (Brytal), containing :—

Sodium carbonate and tri-basic sodium phosphate. Temperature 165° to 190°F. Current density 50/60 amps./sq.ft., reduced after formation of viscous film to 25 amps./sq.ft. Voltage 15volts. Time 5–8 minutes. Rinse articles quickly in clean cold water when completed, then in hot water, and dry.

I personally have carried out a fair amount of experiments on the electropolishing of aluminium and aluminium alloys with solutions of sulphuric acid, phosphoric acid and glycerine, at an aeroplane factory.

A sulphuric phosphoric chromic bath, with others, was published in an American journal, and the phosphoric chromic bath was stated to be used for copper, brass, and certain non-ferrous alloys.

I performed some research work with the sulphuric phosphoric chromic baths, and they gave very satisfactory results with aluminium alloys.

The fact that chromium, molybdenum, tungsten, and uranium belong to the same group (VI) in the table of elements led me to experiment further. It is elementary that elements of one sub-group are similar in many of their characteristics. Therefore, having worked with chromium trioxide I thought of testing the trioxides of the elements of the same group for the purpose of electropolishing. I ruled out uranium and tungsten salts as being too expensive for industrial purposes and limited my choice to molybdenum trioxide, $MoO_3$. This does dissolve in water, forming molybdic acid, $H_2MoO_4$, similarly to chromium trioxide, $CrO_3$, which dissolves in water to form chromic acid, $H_2CrO_4$.

This molybdenum trioxide gave very good results—the solution being made as follows :—

| | |
|---|---|
| Sulphuric acid ... ... ... ... ... | 28% |
| Phosphoric acid ... ... ... ... ... | 50% |
| Water ... ... ... ... ... ... | 12–15% |

Molybdic acid containing molybdenum trioxide 30 gms. per litre. Temperature, 80–90°C. Current density, 80–90 amps./sq.ft.

## Advantages and Uses of Electropolishing

Electropolishing requires very little manual effort, and is also completed in a short time, compared with mechanical polishing.

One of the great advantages of electropolishing is that it requires no more time to polish a large article than it takes to polish a small one. In mechanical polishing, the time expended in polishing an article is about proportional to its area ; so that the man-hours consumed to polish two articles of the same kind by mechanical means are twice the man-hours required to polish one article.

Electricity polishes two articles in the same time as it polishes one. It must be granted, though, that the handling in and out of the electrolytic vat would take more time for two articles than for one.

It must also be stated that there are kinds and grades of mechanical polishing with which electropolishing cannot compete ; it has limitations. Between the limits of possibilities of the two methods, many applications are found where electropolishing and mechanical polishing overlap, supplementing or complementing each other to the great advantage of the user of both methods.

## Electropolishing for Appearance

In electropolishing for appearance it is possible to obtain a colour tone or a brilliance exceeding what is possible by mechanical methods such as bob polishing, wheel polishing and tumbling, although you cannot equal mop polishing.

Stainless steel is very amenable to treatment by electropolishing, whether the steel is as sheets, rods or bars which have been rolled or whether it is as castings. In the case of castings, especially those with intricate recesses, electropolishing scores handsomely ; the castings can easily be sand blasted which gives them a dead grey tone, then electropolished, when a sparkling brilliance is given them. Combinations of tones giving relief effects are obtainable.

Most industrial metals, nickel, monel, nickel silver, steel, aluminium, copper and brass respond to treatment by electropolishing.

Electroplated metals can also be electropolished. Do not forget, however, that most metals can be plated with a bright and polished appearance by using the appropriate brightening electroplating solution.

## Electropolishing as a Roughing Polisher

In several polishing applications, advantage accrues to electropolishing as a roughing operation, in that around 80 per cent. of the wheel work can be eliminated. This would include all of the hard-faced wheels ; for one example, in finishing stainless steel articles formed from 2B mill-finished sheet, only a soft-faced buffing wheel was required, after electropolishing, in order to duplicate a complete wheel job.

## Electropolishing as a Remover of Metal

In addition to its utility for metal finishing, electropolishing offers interesting and practical applications in machining metals, where appearance is not of primary concern but where uniform metal removal is. For example, in one installation several thousand parts are electropolished by two operators in a single shift, to remove simply and uniformly 0·0005 in. of metal. The same production formerly required three men, three shifts, on machines.

## Electro-deburring

There are many instances where sawing, grinding and stamping burrs, etc. are more economically removed by electropolishing. Since burrs are at the edges, they are at the location of most rapid metal removal during electropolishing. Burrs that are difficult of access for mechanical removal can thus be more easily removed.

## Electropolishing as a Tool for the Electroplater

In its role as a machine tool, electropolishing holds interesting possibilities for electroplaters, particularly where heavy plate is to be put on for engineering or mechanical reasons, rather than thin plate for decoration or protection.

The benefits of electropolishing prior to heavy electroplating, particularly with iron, nickel or chromium, derive from the fact that metal is removed without accompanying mechanical work, which introduces heat effects, strains, tearing, deranging of the crystal structure of surface layers, etc. Consequently, the electropolished surface (*a*) is as free from strains as the original metal; (*b*) has a structure that is characteristic of the body of the metal; (*c*) is free from metal fragments and layers of broken-down crystal structure and (*d*) is not influenced by heating effects, from mechanically working the metal.

## Electropolishing for the Inspector

For metallographic inspection in the laboratory, specimens of metals are polished before being inspected under the microscope. The polishing of these specimens by mechanical methods is very tedious and time-consuming.

Electropolishing permits a great reduction in the cost of preparing these specimens for examination. A portable electrolytic cell is a useful form of cell to employ for this purpose. It consists of a little box, cubic in form and only a few inches long and wide. On one side is an electrode, the cathode made of lead; on the other, an aperture on which the specimen is fixed with a spring.

The box is filled with solution and the current passed through. Many solutions for the laboratory have been published in technical journals these last ten years.

**Bibliography**

Although some of the views expressed are the result of experiments personally carried out, and the way of expressing some theories is my peculiar fashion of making them available to the engineer who is not an electro-chemist, I am indebted to the following authors whose works, or extracts from whose works, I have studied :—

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W. Blum.
Blum and Hogaboom ("Principles of Electroplating and Electroforming"—McGraw-Hill, New York, 1924).
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Jacquet.
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M. H. Li.
Liesegang.
Madsen.
F. C. Mathers.
J. E. Myers.
H. H. Uhlig.
S. Wernick, Ph.D., M.Sc.

## DISCUSSION

MR. ORR : Although I consider your lecture is a very fine one, as it is rather theoretical I should like another lecture at a later date, dealing more with workshop practice.

I should like to ask a question about electropolishing. Take the case of an electric iron. It is highly important that it should have a very good finish if it is going to sell. Can you get such a finish by electropolishing only ?

MR. CHANDON : Replying to your first question, I should be pleased to give a lecture on bright electroplating and electropolishing workshop practice.

About finish, in many instances electropolishing is not complete in itself, and some mechanical polishing is necessary.

MR. ORR : If you have to finish by mechanical means, I do not see that electropolishing is going to give you any great economy.

MR. CHANDON : But I said in the course of my lecture that it had done 60-80% of your mechanical polishing ; that is a worthwhile amount. It has done what you would have done with the bob and wheel. All you have to do after electropolishing is to use the finishing mop. Therefore, you have saved many man-hours.

MR. ORR : Is it possible by electrodeposition to build up an undersize part to definite dimensions and thus avoid re-machining ?

MR. CHANDON : No, it is not possible. The deposition of metal must be thicker than required and then the part ground to size, if accuracy is necessary.

MR. R. G. RYDER : If I understood Mr. Chandon aright when he was talking about electropolishing, he said a viscous film was formed over the article to be polished. The high points stuck out of the film. I don't see why that should be. Why is the film not a uniform depth over the whole surface ?

MR. CHANDON : It is difficult to give the answer in words. Shortly, capillarity and surface tension cause the viscous film to flow itself down the crevices and hollows existing over the surface of the anode. It is comparable to mountain peaks protruding through banks of clouds.

MR. RYDER : In the electroplating bath you said you put in a substance which prevented the formation of large crystals of the plated metal and thus produced a better finish. The prevention of the formation of large crystals was due to the deposition of this other substance amongst the crystals, but I think you stated that this substance subsequently broke away. Does this not make your plating porous ?

MR. CHANDON : No ; the substance does not break away. It remains occluded between the metallic crystals and is, of course, an adulterant. It does not, however, make the metal porous. On the contrary, having produced a metallic surface made up of smaller crystals, the plating is more solid than if it had been made up of larger metallic crystals.

MR. RYDER : Then you have not got a pure plating mixture ?

MR. CHANDON : I quite agree. However, these particles are so small that they do not exist to the human eye ; even with a magnifi-

cation of many thousand times you would not see them. The process, therefore, does not detract any of the beauty or usefulness of the plated metal.

MR. EVERIN : Can you tell us what relationship there is between the thickness of the plate deposited, the solution in the tank, and the time of immersion in the tank of any article when plating ?

MR. CHANDON : The amount of metal that is deposited is directly proportional to the intensity of the current ; that is the amperes as represented by "I" in the current. Of course, it is also directly proportional to the time during which the current is flowing. The amount or weight of metal that is deposited is only proportional to that ; it has nothing to do with the strength or concentration of the solution.

The concentration of the solution, however, produces variables. The higher the concentration, the less the resistance of the solution to the passage of the current, and therefore the higher the current density that can be passed through the bath. If you increase the concentration and keep the current intensity the same as before, you do not have any change in the amount of metal deposited.

The thickness of the deposit does not follow quite in the footsteps of either the time or the current, because the thickness of a deposit is never regular. It is always thicker on those parts nearest to the anode and is very much less in recesses and inside corners. Your amount or weight of metal deposited cannot be, therefore, measured by the thickness of deposit at one spot.

MR. FENNER : When I was an apprentice the old-timers used to say: "Highly polished and deeply scratched." What is the relationship between an electro-polished surface and a mechanically-polished surface ? In other words, which is the smoother ? Because a surface reflects light is it necessarily smooth or flat ?

MR. CHANDON : To part one of your question, I reply that a mechanically polished surface is smoother than an electropolished surface.

To part two of your question, I say that for a surface to reflect light it need not be either flat or smooth. Electropolishing gives brilliance (high power to reflect light) even to rugged metal surfaces. I have shown you a sample of such work on an aluminium alloy I circulated round the room.

Mechanical polishing, on the contrary, produces smoothness because it bends down the molecules or clusters of molecules of the metal, filling the valleys with the crests. Electro-polishing eats the tips off the crests. Neither process produces flatness in the sense understood by surface grinding, for example.

MR. HOLDEN : I am interested in the electropolishing of brass, and I can do it very satisfactorily, but I have failed so far to plate on it after electropolishing, the reason being that you make the surface polarised.

MR. CHANDON : This may be right.

MR. HOLDEN : Do you know of any method of making that brass surface depolarized after being electropolished ?

MR. CHANDON : I cannot give you any information on that at the moment.

A VISITOR : You mentioned electropolishing of stainless steel sheets. Just what effect has it on the grain structure and drawing qualities of the metal ?

MR. CHANDON : It only affects the surface to a very small depth indeed—a few microinches. Therefore it does not affect the grain structure of the metal and does not affect the tensile strength and consequently the drawing qualities. I have personally prepared test pieces to check this, and experiment has proved no change in the tensile strength.

Before closing, I would like to draw your attention to another application of electroplating, which is very interesting.

In aircraft and in many other industries, you sometimes have to produce pipes and articles which mechanically are very difficult to produce. Here is a pipe with five outlets, and which has been made of copper. That copper has been deposited on an alloy of low melting point. The process is as follows :—

You make a mould with moulding sand and cast an alloy in that mould. Then you copper it to a certain thickness as required, melt the alloy metal, polish the outside, and you are then left with a pipe having five outlets that has been produced by electrodeposition at a trifle of the cost, both of tooling and of production, that mechanical means would have necessitated.

I know this to have been done very satisfactorily to produce in nickel some pipes for aircraft which could not otherwise have been easily produced.

MR. WESTALL : We are very much indebted to Mr. Chandon for coming along tonight and giving us this lecture. I am afraid we, as engineers, have only got a passing acquaintance with this particular branch of engineering, but when we come to consider the various metallic surfaces and finishes that we can obtain by this process, it must bring it to our minds forcibly that there has been quite a lot of back-room work done on this particular subject.

In addition to the surfaces we obtain, I think there has been a

great deal done during the last few years on salvage work by this process. In our own particular firm, there has been, during these last few years, many thousand pounds' worth of work salvaged which would otherwise have been scrapped.

I am sure we have all enjoyed this lecture, and no doubt we are hoping at some future date to hear Mr. Chandon again. I hope he will be able to make it for us. I have much pleasure in proposing a very hearty vote of thanks to Mr. Chandon for coming along and giving us the benefit of his experience.

MR. CHANDON: My dear friends, I thank you all.

# Research Department : Production Engineering Abstracts

## (*Prepared by the Research Department.*)

NOTE.—*The Addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough. Readers applying for information regarding any abstract should give full particulars printed at the head of that abstract including the name and date of the periodical.*

### HEAT TREATMENT.

**Shrinking and Hardening Track Rollers in One Operation.** (*Machinery*, 25*th April*, 1946, *Vol.* 68, *No.* 1750, *p.* 521, 6 *figs.*)

With an application of the Tocco induction-hardening process, assembly is achieved by shrinking the rollers on the hub after heating. As the shrinkage occurs, the roller treads and the outside surfaces of the roller flanges are simultaneously hardened by a water quench. Eight steps, performed manually, have thus been eliminated.

**Induction Heating Can Make Money on a Job-Shop Basis.** (*The Machinist*, 6*th April*, 1946, *Vol.* 89, *No.* 52, *p.* 2644, 7 *figs.*)

With flexible equipment, plants can do induction heating work for others on a short-run basis. Brazing and hardening jobs, and suitable equipment are described.

### COOLANT, LUBRICANT.

**Lubricants for Cutting Tools.** (*Machine Shop Magazine*, *April*, 1946, *Vol.* 7, *No.* 4, *p.* 51.)

The object of using a cutting fluid is to lubricate the tip of the tool, and to carry away the heat generated and thus produce the best possible surface finish, reduce wear on the tool and prolong tool life, reduce the power required to drive the machine, and permit the use of high spindle speeds. The best practice is to use a copious but slow flood of oil towards the work from one side of the tool. To ensure the oil reaching the tool tip is more important than the quality of the oil. The action of a cutting fluid is described and attention is drawn to the damping of vibration in addition to other functions.

It is usual to classify as straight oils or soluble oils, but the important feature of a cutting oil is the compound of oils and fats which forms the base of the fluid. The advantages of using a water-soluble compound are : that it is the cheapest, the best coolant, and easy to remove from the work. The properties of soluble oils are discussed. For heavy duty work, or when using costly cutting tools, the use of straight cutting oils is advisable and the properties of such oils are also discussed. As a general guide to the selection of a cutting fluid, the cost of the oil is related to the cost of the cutting tool. The temperature of the fluid has an influence on tool life and, where practicable, it should be controlled at about 70°F. Below this temperature, straight oils lose their penetrating properties, and at higher temperatures the film strength suffers. Soluble oils at high temperatures lose the cooling capacity which is the chief property. The cutting speed and pressure must be considered since these vary widely and affect the relative importance of load bearing and penetration.

The essential functions of a grinding fluid are to cool the work and the wheel, keep the wheel clean and free-cutting, and wash away the particles of metal and grit. The types of coolant are discussed. A general purpose oil would be very desirable since the use of the most appropriate oil for each job is impracticable, and usually the choice can be narrowed down to one straight oil and one soluble oil, with possibly a separate coolant for grinding. Health hazards are rarely actually caused by contact with the cutting oils and operators can help themselves to a very great extent by frequent washing and using protective creams.

**How to Lubricate Metal-working Machines,** by Harold L. Flynn. (*The Machinist*, 30*th March*, 1946, *Vol.* 89, *No.* 51, *p.* 2615.)

Fundamentals of lubrication and the sources, compositions and tests of lubricants are first outlined. Typical lubricators and systems are then described for gears, ways, slides and bearings. Information is also given on the care and handling of oil and possible future developments.

**Centralized Sump Conditions Cutting Oils.** (*The Machinist*, 20*th April*, 1946, *Vol.* 90, *No.* 2, *p.* 41.)

The water-cooled centralized sump, as well as cooling and cleaning the oil, is also used for sterilizing it.

## EMPLOYEES, APPRENTICES.

**Apprenticeship Training for the Machine Tool Industry,** by H. Teasdale. (*The Machinist*, 27*th April*, 1946, *Vol.* 90, *No.* 3, *p.* 73.)

Part I. This article suggests methods of training high-class craftsmen from whom factory executives can eventually be selected. The primary aim in apprentice training should be the production of skilled and conscientious craftsmen. But the inculcation and development of qualities of leadership in potential executives is also important. Careful selection is necessary in the machine-tool trade where the annual intake is small, and it is possible to attract very suitable boys with the co-operation of headmasters. Selection should include a test of intelligence, tests of ability and a carefully conducted interview. All appointed in any one year should commence on the same date, with a systematic introduction to their duties. The relative merits of training in the works or in a separate department, are discussed. The author favours works' training for the small or medium-sized firm and describes a scheme for planned training. The plan of progress through the works should function automatically and be unaffected by production requirements. A scheme for an annual intake of six apprentices is shown. To help production the number of apprentices in each department must be kept constant. Practical difficulties in instituting such a scheme are discussed.

## FOUNDRY, CASTING.

**Using Synthetic Resin Core Binders,** by H. L. Gebhardt. (*Foundry*, *February*, 1946, *Vol.* 74, *No.* 2, *p.* 110.)

The use of liquid and solid urea-formaldehyde binders for Al and Mg foundry work is discussed.

(*Communicated by the British Non-Ferrous Metals Research Association.*)

**Weight Estimation,** by H. K. Barton. (*Machinery*, 25*th April*, 1946, *Vol.* 68, *No.* 1750, *p.* 542, 6 *figs.*)

Methods of approximation for irregular die-cast shapes are explained.

## GEARING.

**The Suppression of Noise in Gears,** by A. B. White. (*Power Transmission, April,* 1946, *Vol.* 15, *No.* 171, *p.* 379, 3 *figs.*)

Part II. Manufacturing conditions affecting noise are accurate division of the teeth and the condition of the machine and tools. Types of tooth finish are discussed. Lapping has met with great success, but shaving and scraping may also be used. The effect of tooth action is briefly considered.

## JIGS AND FIXTURES.

**Jigs and Fixtures can be Simple.** (*The Machinist, 30th March,* 1946, *Vol.* 89, *No.* 51, *p.* 2601, 11 *figs.*)

Simple, easily operated units are described.

## MACHINE ELEMENTS.

**Drawing Office Practice in Relation to Interchangeable Components,** by C. A. Gladman. (*Journal of the Institution of Mechanical Engineers, March,* 1946, *Vol.* 152, *No.* 4, *p.* 388, 41 *figs.*)

The paper describes some features of the work of a special Service Committee set up by the Admiralty, for the purpose of standardizing drawing office practice in certain of their design departments. Basic principles are established for the guidance of designers and draughtsmen when preparing drawings for interchangeable components, and logical methods of approaching solutions to dimensional problems and of stating these on drawings are discussed.

Particular attention has been paid to such problems as the best method of analysing, and dimensioning and applying tolerances to interchangeable components which involve tapered, concentric, or positional features such as holes and studs. Stress is laid upon the need for foreseeing, and avoiding as far as possible in the design stage, any special difficulties which may arise in practice in the construction of manufacturing equipment, or of practical gauges for controlling the dimensions of components.

It is understood that the British Standards Institution has in contemplation the preparation of a handbook dealing with the subject of the dimensioning of production drawings and of indicating the tolerances on them. Such a handbook, when completed, would not only be of great use to industry at large, but would also form a valuable textbook for courses of instruction to engineering students in technical colleges and universities. It is hoped that this paper may be the means of stimulating thought on this aspect of interchangeable manufacture, and that it will provoke discussion which may lead to the development of a uniform system suitable for use both by Service Departments and by industry in general. In addition to the paper itself, a valuable discussion is reported.

**Tolerances on Assemblies,** by Benjamin Epstein. (*The Machinist, 20th April,* 1946, *Vol.* 90, *No.* 2, *p.* 47, 6 *figs.*)

Elementary statistical methods are used in this article as a basis for establishing a sound procedure for the determination of assembly tolerances.

## MACHINING, MACHINE TOOLS.

**Machine Foundations.** (*Machine Shop Magazine, April,* 1946, *Vol.* 7, *No.* 4, *p.* 61, 3 *figs.*)

Two vibration-free heavy machine foundations for the support of large gear hobbing machines in assembly necessitated the following: the construction of

a floor bearing so that if movement of the machine should take place through subsidence it would all move in one plane ; a foundation bed which could be unevenly loaded without showing appreciable departure from truth ; insulation of floor vibrations from other plant, and a foundation bed free from vibrations when gear hobbing machines were being tested. A foundation comprising a 1–6 mass concrete bed carried in a cork slab cradle varying from 2 ins. to 4 ins. thickness, embedded in bitumen, and with ¾ in. layers of asphalt, was found suitable and its construction is fully described.

**Machining of Aluminium and Its Alloys,** by E. von Burg. (*Light Metals, February,* 1946, *Vol.* 9, *No.* 97, *p.* 94–104. *English account based on Schweizer Archiv, June,* 1944, *Vol.* 10, *No.* 6, *p.* 161–177, *and Techn. Rundschau,* 1945, *Nos.* 48, 49.)

(*Communicated by the British Non-ferrous Metals Research Association.*)

**The Efficient Control of Twist Drills,** by H. Moore. (*Aircraft Engineering, March,* 1946, *Vol. XVIII, No.* 205, *p.* 103, 6 *figs.*)

Notes are given on some problems in drilling. These include small holes in thick metal, holes in thin sheet, drilling at an angle, and avoiding drill breakages when drilling through uneven material.

**Pointers on Abrasive Points,** by William S. Hallowell and William S. Hemsley. (*The Machinist, 30th March,* 1946, *Vol.* 89, *No.* 51, *p.* 2608.)

Modern portable grinders can drive the smallest mounted abrasive wheels and points at efficient surface speeds. Fields of application, exclusive of precision internal grinding, are : (1) Finishing moulds, dies and metal patterns ; (2) Tool grinding ; (3) Snagging and finishing comparatively inaccessible spots ; (4) Finishing welds ; and (5) Deburring the edges of gear teeth, holes, slots and sheets.

For hard materials or scale, abrasive points wheels have a distinct advantage. Where the finish need not be of especially high quality, rotary files are usually the best choice on materials which are not too hard for them. It is important that the wheel be of the right shape and of the correct specifications as to type of abrasive, grit size, type of bond and grade. Operating conditions must also be correct as to wheel speed and pressure. Wheel specifications are briefly reviewed. The correct speed depends upon safety, finish required, grade, material, wheel contact and speed range of the machine.

**Lapping Diesel Fuel Injectors,** by Fergus Anderson. (*Machinery, 4rh April,* 1946, *Vol.* 68, *No.* 1747, *p.* 439, 1 *fig.*)

Only one gauge is used as a standard for the sizing of the male laps. The female laps are then made to be a fit on the male laps.

**Life Tests on Diamond Lapping Wheels.** (*Machinery Lloyd, 13th April,* 1946, *Vol. XVIII, No.* 8, *p.* 91, 1 *fig.*)

Fifteen inches of ½ in. diameter sintered tungsten carbide rod were ground away without measurable wear on the wheel.

**Surface Broaching Valve Rocker Arms,** by H. H. Gotberg. (*Machinery, 28th March,* 1946, *Vol.* 68, *No.* 1746, *p.* 410, 6 *figs.*)

Five dual-ram surface-broaching machines are used to machine the various surfaces on the right- and left-hand rocker arms in five operations per arm.

**Articulated Head Gives Universal Range to French Milling Machine.** (*The Machinist, 20th April,* 1946, *Vol.* 90, *No.* 2, *p.* 35, 3 *figs.*)

The outstanding feature of this machine is the method of mounting the spindle

to give universal adjustment at any angle and in any plane, by mounting the spindle assembly in a cylindrical member which is adjustable in the axial plane, and which can also be adjusted radially, while the spindle assembly itself can be pivoted at right angles to this member.

**Profile Milling Airscrew Blades at 11,000 feet per minute,** by Henry L. Wainwright. (*The Machinist*, 13*th April*, 1946, *Vol.* 90, *No.* 1, *p.* 1, 4 *figs.*)

Specialized cutter design reduced machining time from 32 mins. to 17½ mins., cost by 37½ per cent., eliminated a noise problem, and gave 260 components per regrind instead of original 2·96. The development of the cutter design is described.

**Spar-Boom Production,** by R. R. Nolan and F. M. Gibian. (*Aircraft Production, April*, 1946, *Vol. VIII*, *No.* 90, *p.* 172, 9 *figs.*)

American milling practice for spar-booms is described.

## CHIPLESS MACHINING.

**New Methods of Metal Spinning,** by E. Weiss. (*Machinery*, 11*th April*, 1946, *Vol.* 68, *No.* 1748, *p.* 457, 15 *figs.*)

It is now possible to spin harder metals, greater thicknesses, and larger diameters than before, and tubes and sheets of almost all metals can be spun. Details are given of jobs and methods, including the hot spinning of steel tubing for high-pressure gas containers.

**Circular Blanks from Rectangular Sheets,** by O. Lichtwitz. (*Machinery*, 11*th April*, 1946, *Vol.* 68, *No.* 1748, *p.* 465, 7 *figs.*)

Methods of calculating the most economical layouts are described.

## MANUFACTURING METHODS.

**Motion Economy,** by F. C. Bailey. (*Aircraft Production, April*, 1946, *Vol. VIII*, *No.* 90, *p.* 188, 4 *figs.*)

Part 1. Motion-study principles can be applied to aircraft manufacture if the fundamental principles, which are described, are understood. The different approach required for aircraft is illustrated by comparison with the mass-manufacture of electrical accessories. The limit chain effect is the most acute problem and special attention to its elimination is given. On one component 185 movements were reduced to 22.

## MATERIALS, MATERIAL TESTING.

**Damping Capacity and the Fatigue of Metals,** by R. F. Hanstock and A. Murray. (*Engineering*, 12*th April*, 1946, *Vol.* 161, *No.* 4187, *p.* 358, 7 *figs.*)

Fatigue failures usually occur without warning, and although attempts have been made to detect the commencement and development of fatigue, metallographic and X-ray examinations, on the whole, have not been successful. Damping capacity, however, may be closely related to fatigue. Research described was undertaken to develop a method of fatigue testing which would allow determinations to be made of the damping capacity of the specimen during the course of the test, and it has been possible to investigate fatigue and damping capacity simultaneously for some aluminium alloys. Eventually the method may be applied to a wide variety of materials. Equipment for the excitation of resonance vibrations, and for the measurement of damping capacity, is illustrated and described.

**Indentation Test for Non-Metallic Materials.** (*Machinery*, 11*th April*, 1946 *Vol.* 68, *No.* 1748, *p.* 485.)

The Knoop indenter and the Tukon hardness tester, developed by the Wilson Mechanical Instrument Company Inc., U.S.A., were described by Mr. Vincent E. Lysaght in a paper presented to the American Society for Testing Materials. The Knoop indenter is a diamond ground to a pyramidal form and producing a diamond-shaped indentation having long and short diagonals of approximately 7 to 1 ratio. The depth of indentation is about one-thirtieth of its length. Very light loads can be applied with the Tukon tester and the hardnesses of a wide range of materials can be obtained, ranging from gypsum (Knoop No. 32) up to carboloy (No. 1050–1500), black silicon carbide No. 2 (No. 2050), and diamond (No. 5500–6950).

**Application of Magnesium Alloys,** by D. A. Tooley. (*Machinery*, 25*th April*, 1946, *Vol.* 68, *No.* 1750, *p.* 527, 3 *figs.*)

Magnesium alloys have a lower specific gravity than any other available structural metals. On a strength-to-weight basis, magnesium alloys do not differ greatly from aluminium alloys, but it is possible to obtain more stiffness with less weight. Disadvantages are susceptibility to corrosion, limited formability at room temperature, low ratio of yield strength to ultimate strength, compared with aluminium alloys, unsuitability for high temperatures and poor abrasion resistance. Cold-working is required to raise the strength and yield point. Suitable production methods are discussed, including bending, drawing, rubber-forming, drop-hammer forming, stretch-forming, dimpling, riveting, and helium-arc, gas and spot-welding. Chemical treatment or suitable paint can prevent corrosion.

**The Mechanical and Metallurgical Aspect of Free Cutting Steels.** (*Machinery Lloyd*, 13*th April*, 1946, *Vol. XVIII*, *No.* 8, *p.* 67, 5 *figs.*)

Steels may be difficult to machine because they are hard, *i.e.* difficult to deform, or because they are tough, though soft. These may be partially overcome by altering the machining technique. They may also be overcome by metallurgical means. Cold drawing gives a strained structure which is easier to cut, and the introduction of sulphur, with suitable precautions, has marked effects on ordinary and stainless steels. Selenium and lead can also be used.

**Silver,** by L. Sanderson. (*Machinery Lloyd*, 13*th April*, 1946, *Vol. XVIII*, *No.* 8, *p.* 95.)

Industrial uses include electrical contacts, hard silver-solders, and as a means of producing higher corrosion resistance combined with better machinability in stainless steels.

**Z.D.A. Abstracts.** (*The Zinc Development Association*, *Vol.* 4, *No.* 3, *p.* 31.)

This monthly review contains 73 abstracts on die casting, rolled zinc, hot-dip galvanizing, electro-deposition, paints, enamels and lacquers, coatings, forming dies, cadmium, metals and alloys, soldering and welding, and associated subjects concerning the uses of zinc and zinc products.

## MEASURING METHODS, APPARATUS.

**Inspection,** by J. Wardell. (*Machine Shop Magazine*, *April*, 1946, *Vol.* 7, *No.* 4, *p.* 34.)

Inspection systems have gradually grown from casual to highly organized methods since the introduction of high production incentive systems. The control of inspection may be left with the production foreman. This is recommended where there is no independent department for planning. Types of

inspection depend on the manufacturing process: thus with autos the frequency of inspection should be related to the tool life. Provided statistics are kept of the amount of scrap experienced, something less than 100 per cent. inspection can be tried. The causes of rejection call for investigation and the use of records is advocated. Copies of rejected work reports should be sent to the progress and estimating departments.

**Detection, Causes and Prevention of Injury in Ground Surfaces,** by L. P. Tarasov. (*Amer. Soc. Metals Preprint* 26, 1945, 53 *pp.*, *B.N.F. Serial* 28,766.)

Deals mainly with steel, with brief references to hard carbides, etc. Methods of detecting cracks, stresses or burn; characteristics of cracks and stresses in ground surfaces; metallurgical factors; grinding factors; possible effects in use of injured ground surfaces; some methods of preventing surface injury. Bibliography.

(*Communicated by the British Non-ferrous Metals Research Association.*)

**Gauge Inspection and Maintenance.** (*Machinery*, 28*th March*, 1946, *Vol.* 68, *No.* 1746, *p.* 393, 10 *figs.*)

The work of the Metrology division at the A.I.D. test house is described. The instruments include the Eden-Rolt comparator for slip gauges, the Brookes level comparator for gauges ranging from slip gauges to long end bars, an interferometer for checking the flatness, an internal-measuring machine for the measurement of diameters, an electro-mechanical lead-testing machine, universal pitch-measuring machine, a universal measuring block for checking angles, and an angle gauge dividing head.

**Check Testing Aircraft Components and Gauges.** (*Machinery*, 4*th April*, 1946, *Vol.* 68, *No.* 1747, *p.* 425, 7 *figs.*)

Operations at the A.I.D. test house are described, including dummy ammunition for setting automatic gauging machines with a double sine-bar arrangement, the use of a tilting rotary table, and the profile checking of streamline wires and other components.

**Optical Locating System Takes Guesswork Out of Positioning.** (*The Machinist*, 13*th April*, 1946, *Vol.* 90, *No.* 1, *p.* 11, 7 *figs.*)

A microscope-equipped master fixture is fitted with a fixture plate and scale block for precision drilling holes with centres held to plus or minus 0·0002 in. on a milling machine.

## SHOP ADMINISTRATION AND SHOP MANAGEMENT.

**Planning and Progress for Variety Production,** by C. D. Mackinnon. (*Machine Shop Magazine*, *April*, 1946, *Vol.* 7, *No.* 4, *p.* 64, 6 *figs.*)

In a works having two or three hundred employees, the personnel required to work the system outlined consists of one full-time and one part-time girl clerk working from the works manager's office, one girl in charge of all drawings in the shops and one engineer progress man and helper in the shops. The duties of the personnel and the principles of the system are discussed in detail.

## STANDARDIZATION.

**The Graphical Representation of Hydraulic Systems,** by M. Hodgson. (*Aircraft Engineering*, *April*, 1946, *Vol. XVIII*, *No.* 206, *p.* 139, 4 *figs.*)

A new series of standard symbols was developed during the war for use in aircraft servicing handbooks in view of the difficulties of using "life-like"

external views, "block" diagrams or detailed sectional views for elaborate systems. The analysis of requirements is illustrated by considerations of an example, shown as a complete diagram, perspective installation diagram, and condensed instructional diagram.

## TRANSPORT AND TRANSPORT EQUIPMENT.

**Scheduled Conveyor Loading Increases Production and Workers' Take-Home Pay.** (*The Machinist*, 30*th March*, 1946, *Vol.* 89, *No.* 61, *p.* 2591, 4 *figs.*)

A bottleneck occurred in the spray booth. The remaining operations are limited only by the quantities of materials which may physically be hung upon the hooks, but in the spray booth the arrangement of the components on the hooks must be such that the operator will have an adequate opportunity to spray them and yet have his waiting time held to a minimum. The layout of the spray booth and the loading pattern which overcame the difficulties are described.

## WELDING, BRAZING, SOLDERING, FLAME CUTTING.

**Soldering and Brazing,** by T. J. Stewart. (*Welding*, *April*, 1946, *Vol. XIV*, *No.* 4, *p.* 169, 14 *figs.*)

Machines of the spot welder type are used for soldering and brazing with suitable electrodes as heating members. Advantages include simplicity of operation, speed, economy, localization of heating, use of semi-skilled labour, the production of components to very close tolerances and economy in the use of materials. In the choice of equipment attention should be given to the quantity of production, adequate transformer capacity with correct electrical and mechanical design, the design of fixtures, the cleaning of material, and the design of electrodes. Electrodes should be periodically inspected and particular attention should be paid to the proper use of fluxes and solders. The correct amounts of fluxes and solders are important. A table of brazing alloys is given and the properties of fluxes are indicated. The design and strength of soldered and brazed joints is discussed, and good design practices are described. These permit both sufficient component strength and ease of satisfactory manufacture. Correct positioning does not always necessitate the use of jigs and fixtures.

**Production Methods by Silver Brazing.** (*Machinery*, 7*th March*, 1946, *Vol.* 68, *No.* 1743, *p.* 297, 13 *figs.*)

Induction heating, gas furnace, and hot dipping methods are available. Silver brazing is cheaper than copper brazing because less work is involved and their strengths are comparable. Examples by the various processes are fully described.

**High Speed Spot Welding,** by Bernard Gross. (*Sheet Metal Industries*, *April*, 1946, *Vol.* 23, *No.* 228, *p.* 767, 5 *figs.*)

The author discusses some of the factors which must receive careful attention to ensure successful high speed spot welding, including machine design, tooling, maintenance, and personnel training.

**Electronic Control in Resistance Welding,** by B. G. Higgins. (*Aircraft Production*, *April*, 1946, *Vol. VIII*, *No.* 90, *p.* 155, 13 *figs.*)

Spot welder and seam welder controls of the ignition type are described, with basic circuit diagrams.

**Applications of Projection Welding**, by R. Bushell. (*Welding*, *April*, 1946, *Vol. XIV*, *No.* 4, *p.* 156, 34 *figs.*)

The article is devoted mainly to the projection welding of mild steel assemblies. The properties of projections for welding sheets and bar material are given, with steel specifications. The design of component parts for projection welding is illustrated by actual examples. Types of machines and the design of jigs and fixtures are also described with the aid of suitable examples.

**Atomic Hydrogen Welding in the Manufacture and Repair of Tooling Equipment.** (*Aircraft Production*, *April*, 1946, *Vol. VIII*, *No.* 90, *p.* 170, 6 *figs.*)

High-carbon steel is deposited on mild steel in the manufacture of new tools, or on to tool steel in the case of repairs. The manufacture of a punch and die is described.

# INDEX TO ADVERTISEMENTS

*As a war-time measure the advertisement section of this Journal is now published in two editions,* A *and* B. *Advertisers' announcements only appear in one edition each month, advertisements in edition* A *alternating with those in edition* B *the following month. This Index gives the page number and edition in which the advertisements appear for the current month.*

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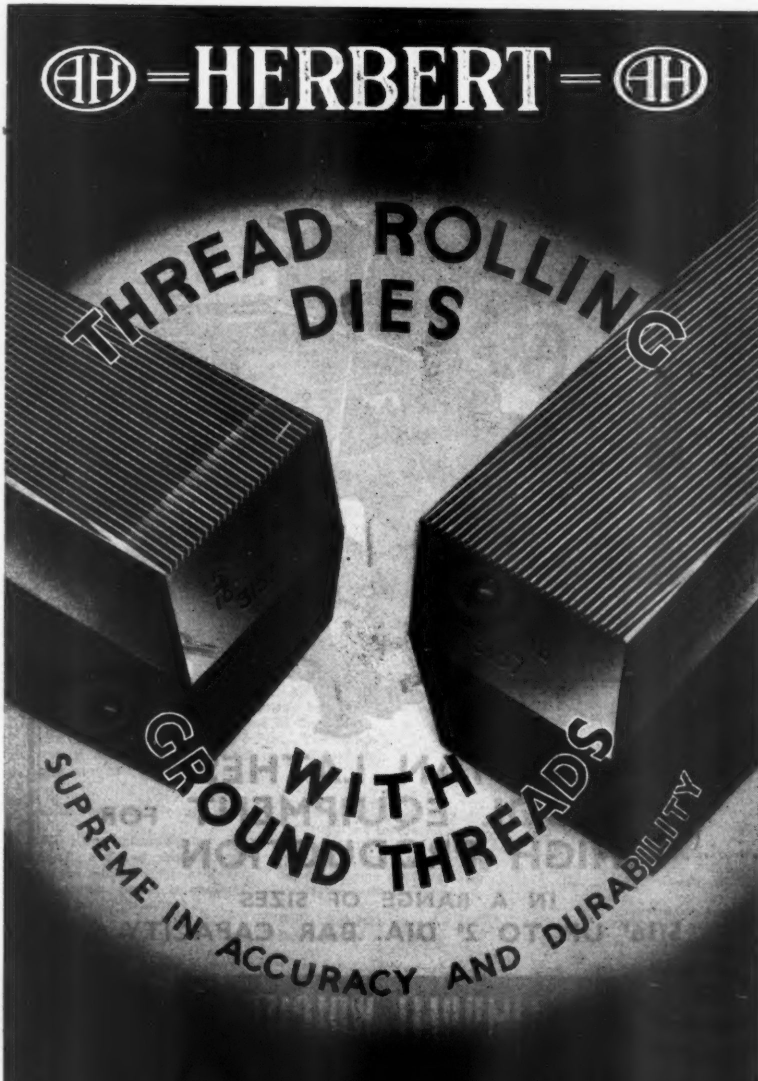
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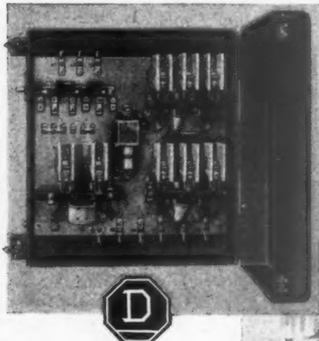



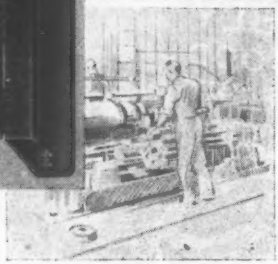

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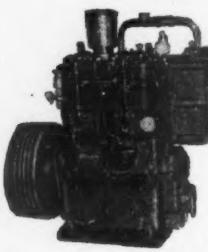

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